Space Weather Technical Forecast

Issued on Saturday, 16 March 2024 at 12:41 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Continuation of S1 a decreasing risk over current UTC weekend.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity measured at GOES16 and 18 has been Low. The 24-hour period started with the tail end of a long period C5.9 flare (that peaked prior to this reporting period at 15/0610UTC) from Ex-AR3599 over the western limb. Activity was otherwise very subdued, with isolated very small C-class flares on a smooth background near the B/C flux boundary.

The current disc comprises a relatively stable set of three numbered and two unnumbered sunspot groups, with all of these apparently magnetically simple.

The main events noted on the disc in the period included a possible filament lift-off in the north centre-disc around 16/0600UTC, perhaps occurring at the same time as a smaller event narrowly in the southeastern quadrant between 0600-0900UTC, with both visible on AIA304, and perhaps faintly in H-Alpha (Learmonth for example). Any resulting ejecta has yet to materialise on coronagraphs, however this is a main aspect of monitoring given the emission locations near centre-disc. Confirmed CME activity otherwise largely appeared to emanate from narrowly behind the southeastern limb. All considered, there is no imagery to suggest new Earth-bound CMEs at the time of writing.

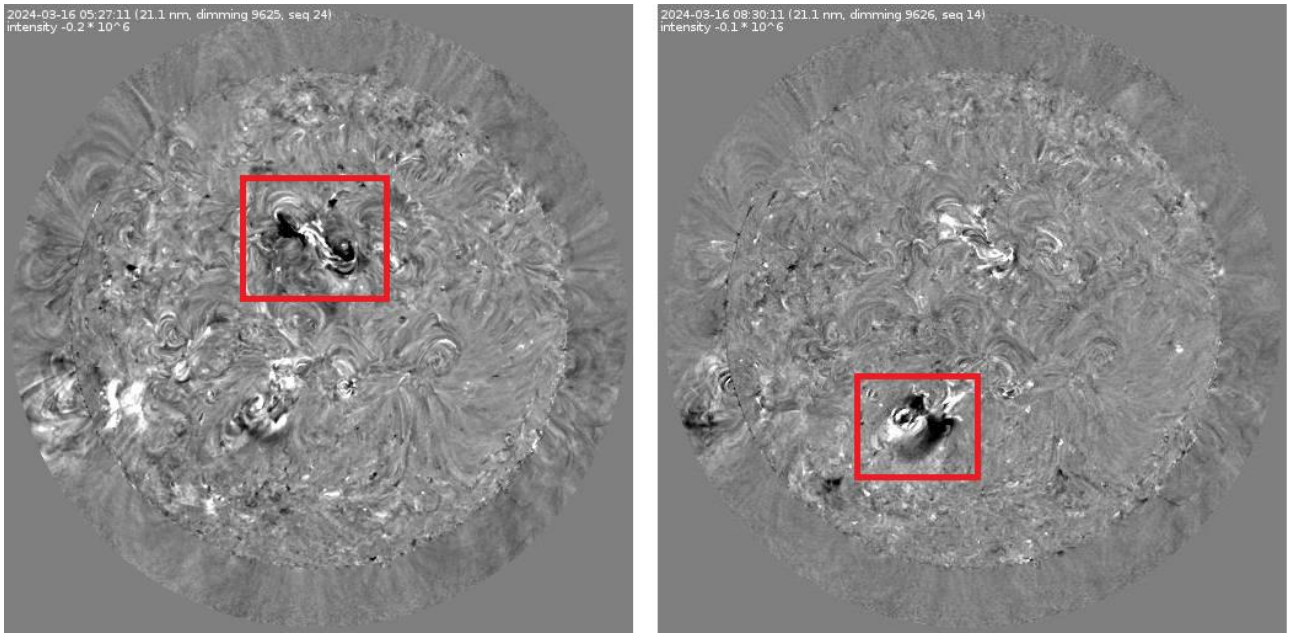

Figure 0: SIDC ROB-processed AIA 211 time integrated dimmings of note in the past 24 hours, showing two potential CME-generating events near centre disc. The left event is more visible in AIA304, and the right in H-Alpha. Coronagraph imagery is pending.

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Solar Wind / Geomagnetic Activity: Solar wind speeds, as observed at L1 by DSCOVR and ACE were perhaps reflective of a slow exit from the fast wind regime of CH09/+, with the phi angle accordingly positive (away from the Sun) throughout. The solar wind speed showed a roughly level trend around 400km/s, with the density level in single-figures ppcc. The IMF showed a very slight decline from a high of 5nT, with the north-south component ranging between +5 and -3nT, with an erratic character but slight co-aligned bias with the Earth's field.

The net result of the above solar wind measures was for provisionally Quiet geomagnetic activity throughout.

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux showed a continuing enhancement beyond S1 in the wake of the 15/0610UTC C5.9 flare from Ex-AR3599. This level was first breached from 15/2050UTC and reached a maximum of 18.8pfu at 16/0905UTC.

High energy electron flux (greater than 2MeV) observed at GOES16 was at Normal Background levels. The observed 24-hour fluence was steady below the Active threshold, with the value at 16/0001UTC being 4.7e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: There is rising Slight Chance of M-class activity as a result of a returning region due over the eastern limb later in the current UTC weekend.

Solar Wind / Geomagnetic Activity: There are up to three glancing incidence CME shocks expected to pass 1AU around 17 or 18 March. Combined with any minor CIR leading CH10/- which is due at a similar time, all considered there is a peak Slight Chance of G1 on these days, else starting and ending the four-day period more reliably Quiet. For a full discussion of the CMEs, please see the Geomagnetic Storms section, and note that no potential CMEs from the current UTC day are included.

Energetic Particles / Solar Radiation: Proton flux at GOES18 is likely to remain in excess of S1 for much of the remainder of the current UTC day, but should fall below by the second half of the UTC weekend and continue its declining trend thereafter - in the expected absence of potent sunspot regions in geoeffective locations should they flare appropriately.

High energy electron flux (greater than 2MeV) is currently at Normal Background levels. Given the expected lack of significant CMEs and fast winds, 24-hour integrated fluence is Expected to remain below the Active threshold throughout.

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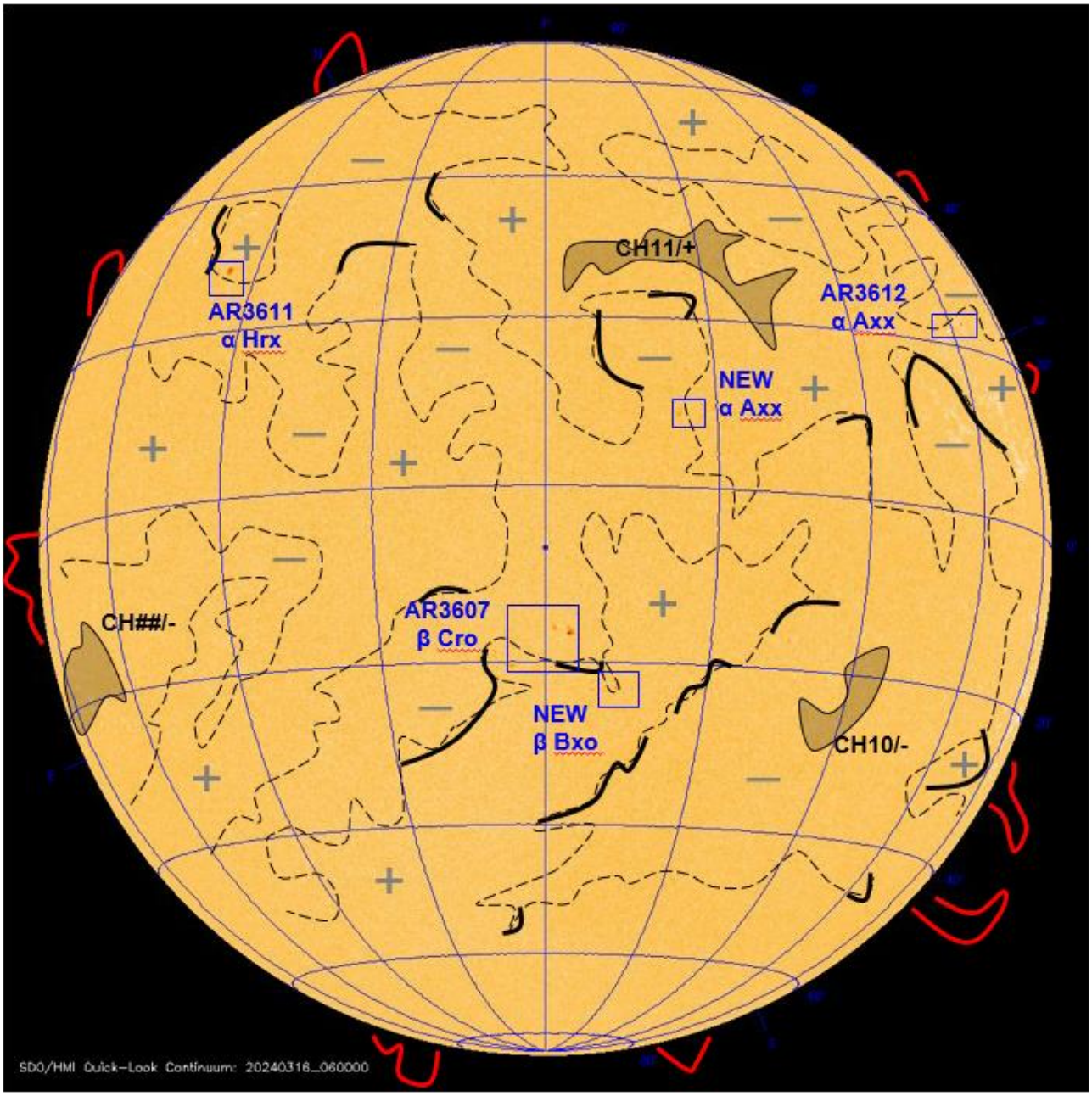
Figure 1. Solar Analysis Valid 16/0600UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

As noted in the Forecast Overview, there are perhaps two candidates for filament eruptions on 16 March that are being monitored for. These do not yet feature in the probabilities and discussion detailed here.

The current cohort of CMEs with possible Earth-bound components include up to three events, although all of these are glances at worst and would most likely have to arrive in combination with each other or any inbound fast wind CIR for any notable effects. These are: firstly, the CME associated with the long-period C5.9 flare from Ex-AR3599 15/0610UTC over the west limb. Secondly, a filament eruption from north-centre disc on 14 March; and thirdly, a CME from 15 March with an unknown source.

Both recent and forecast fast wind enhancements are expected to be relatively minor in the period, with CH10/- both small in stature and not possessing an analog from last pass. As stated, for any risk of G1 any CIR would likely have to arrive in tandem with one of the several CME candidates detailed above, which is overall considered a Slight Chance that should peak through 17 and 18 March, else becoming more reliably Quiet to start and end the four-day period.

The slightly elevated winds currently observed are thought to emanate from a weak, but waning, connection to a high speed stream from CH09/+. The small negative polarity coronal hole, CH10/- will rotate into a more geoeffective position later day 1 (16 Mar) or more likely day 2 (17 Mar), however it is such a small feature that any HSS from this is unlikely to give significant impacts at Earth. We also have CH11/+ in the northern hemisphere, which was present on the previous rotation, but gave little impact at Earth and similar is expected this time around.

Mostly Quiet or Unsettled (Kp 0-3) conditions are expected over the period, with a chance of an Active (Kp 4) and a Slight Chance of G1/Minor Storm (Kp 5) intervals on days 2 and 3 (17 &18 Mar) should any of the 2 glancing CMEs/the CME shock or a stronger connection to the CH10/- HSS occur.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	10	10	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Most likely nil.

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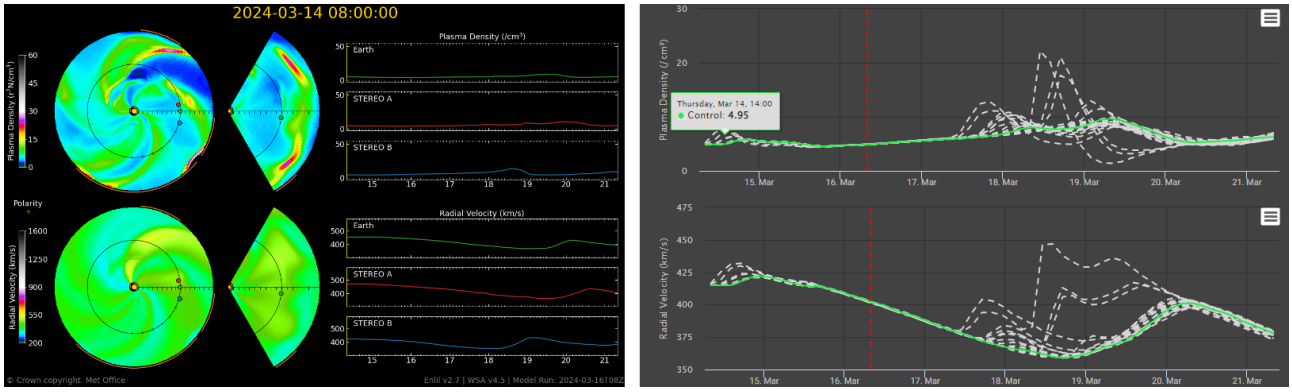
Figure 2: Latest MOSWOC Enlil run and ensemble (badge time 16/0800UTC), showing the effects of numerous minor glances in the 24-48 hour range. Fast wind influence is relatively minor over the same interval, with Enlil's suggested timing for CH10/- perhaps on the late side but accepted in terms of magnitude. It remains the case that the largely un-moved deterministic run is the most likely course of events, i.e. largely Quiet geomagnetic activity throughout.



Radio Blackouts - X-Ray Flares:

Solar activity has become Low in the wake of Ex-AR3599's departure over the western solar horizon to end the past UTC working week. Helioseismology suggests that a larger region is projected to rotate onto the disc later in the current UTC weekend - this may be Ex-AR3590, which was the source of several Strong flares on the previous rotation. There is already some possible CME-related dimming activity from near its expected location on the far side. The return of this region is reflected by the slight increase in flare probabilities from 17 March, however confidence in this is low until the region rotates onto the disc and can be assessed.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	10	20	20	20
Very Active	R3 to R5 X Class	No	1	5	5	5

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Figure 3: The past week in C-class flares and above recorded at PROBA2 (courtesy of SIDC ROB). Note the dominance of now Ex-AR3599 in the southwest, with very few flares on the remainder of the disc.

Solar Radiation Storms - (High Energy Protons):

Solar radiation levels are currently in exceedence of S1 in the wake of the response to the C5.9 flare peaking 15/0610UTC. Proton levels themselves appear to have plateaued near 18pfu in the current UTC morning, and should now show a gradual decline over the coming hours. The main forecast focus is therefore the rate of exit from S1, and not the likelihood of further enhancements, with the latter now considered unlikely given Ex-AR3599's position well onto the far side and the lack of any suitable successor on the current disc.

A regression to the raw values for further S1 storms is therefore expected into the new UTC working week, which actually stands below recent values in being near 1% given the apparently magnetically simple sunspot regions facing Earth at present.

Radiation Storms	**Level (cm^{-2} sr^{-1} s^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Active	**≥ S1**	No	99	20	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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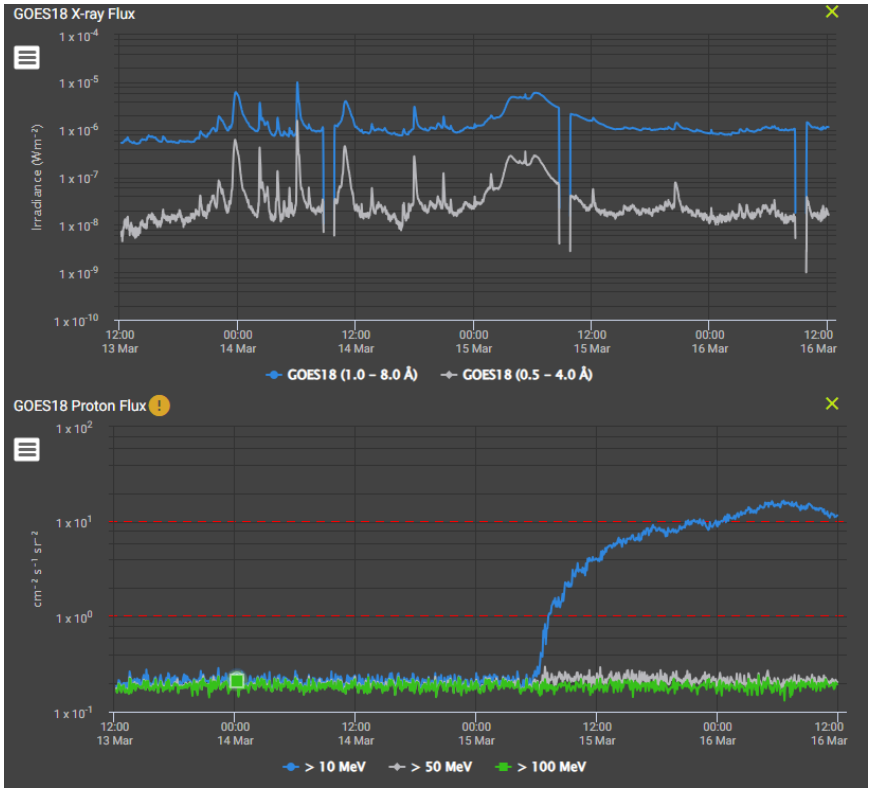
Figure 4: GOES18 X-ray flux and proton flux in the past 72 hours. The response to the C5.9 from Ex-AR3599 is ongoing at the time of writing, showing a relatively soft spectral response, with 50 and 100MeV protons largely un-moved. GOES18 is shown in preference to 16, the primary given the timing of the equinoctal eclipses of the instrument (occuring during the peak flare in this case on GOES16).



High Energy Electrons Event (≥ 2MeV):

No significant fast wind enhancements nor CMEs are due in the period, and there is not any mechanism to increase electron flux and fluence beyond their current subdued levels. MOSWOC REFM indicates as such, although this must be treated with caution given the possible polluting influence of CMEs in the period and the lack of clear analogs to CH10/- on last pass.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	1	1
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

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